MAGNETIC RESONANCE MICROSCOPY OF FIXED BREAST TISSUE

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Target Audience Researchers and clinicians interested in the biophysical basis of diffusion contrast in breast tissue and optimization of DWI for cancer detection.

Purpose Conventional MRI has high sensitivity for breast cancer detection but poor specificity. Addition of DWI to a breast exam may increase specificity to around 90% [1]. However, the biophysical basis of changes in diffusion weighted contrast in the breast and other non-neural tissue remains poorly understood [2]. In prostate tissue, MR microimaging has recently been used to characterize diffusion at a spatial resolution approaching the cellular scale, providing insights into several clinical observations including ADC and anisotropy changes [3]. The study described here investigates the microscopic diffusion properties of formalin fixed breast tissue.

Methods Three normal breast tissue specimens were formalin fixed, immersed in 0.2% v/v Magnevist, and imaged on a 16.4T Bruker AV700 microimaging system (5 mm solenoid RF coil, Micro5 gradient set: 5 G/cm/A) using a 3D spin echo DTI sequence at 40µm isotropic resolution, δ/Δ = 2/12 ms, TE/TR = 20/500 ms, b=1500 s/mm^2 with 6 directions and a single 'b=0' reference measurement. A rapid acquisition with relaxation enhancement (RARE) sequence with variable repetition or echo time was used for T_2-weighted imaging. Parametric images were calculated using Matlab.

Results Normal breast tissue glandular architecture was visible in the MR images. Fig. 1 shows histology and typical parametric maps of T_2, mean diffusivity (MD), and fractional anisotropy (FA). About 50% of the slice shown is occupied by fat. We did not calculate diffusion parameters for fat voxels (low signal at 'b=0'). Table 1 provides a summary of voxel statistics from regions of reasonable signal-to-noise ratio.

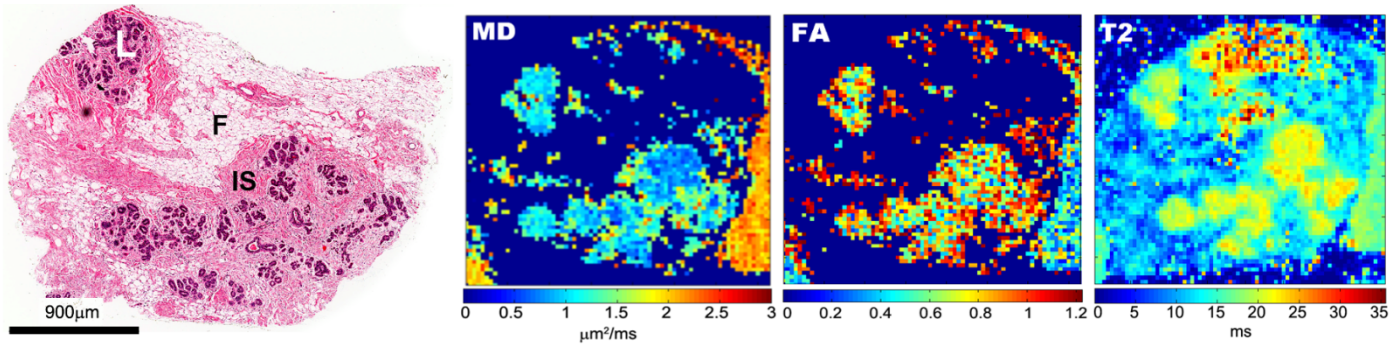

Fig. 1. H&E stained tissue section of normal breast glandular tissue (L= glandular lobule, IS = interlobular stroma, F = fat), mean diffusivity (MD), fractional anisotropy (FA), and T_2 map in approximately the same plane as the histology section.

Table 1. Summary of voxel mean diffusivity and T_2 estimates

	MD (µm^2/ms)	**T_2** (ms)
	Mean ± SD (num voxels)	
Gland lobule	0.93 ± 0.28 (5093)	20.9 ± 1.8 (846)
Inter-lobular stroma	1.42 ± 0.40 (2082)	16.2 ± 1.8 (393)

Discussion Epithelium-rich tissue in the normal breast gland lobules has lower ADC than adjacent interlobular fibromuscular stroma. The observed lobule ADC (~0.9 µm^2/ms) is higher than the 'epithelium' ADC of fixed prostate tissue glands (~0.5 µm^2/ms) [4], possibly due to partial volume effects. In breast tissue the epithelium-lined gland acini are smaller than those in the prostate, and lie in a matrix of intralobular fibrous stroma which, if of similar ADC to the interlobular stroma (~1.4 µm^2/ms), would lead to a voxel ADC higher than that of 'pure' epithelium. The FA data is noisy, however, there appears to be a trend towards higher FA in the interlobular stroma than in the lobules, as would be expected.

Conclusions Breast tissue glandular epithelium is similar to prostate tissue epithelium in having a low ADC relative to adjacent tissue. Low ADC may be a distinctive and diagnostically useful feature of glandular epithelia, not only in prostate and breast, particularly considering that 80-90% of all cancers are of epithelial origin.

References

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